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CENTRAL INTELLIGENCE AGENCY

INFORMATION REPORT

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SECURITY INFORMATION

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THE SOURCE EVALUATIONS IN THIS REPORT ARE DEFINITIVE.
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(FOR KEY SEE REVERSE)

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PROJECT "ZENITH"

1. The Zenith missile, by utilizing solid propellant (powder) rockets, was designed to be used against flying targets for altitudes up to 18 kilometers. The maximum flying time was 20 seconds. The blast effect was supposed to be sufficient to achieve total destruction or, at least, flight incapacitation, when a hit was scored against heavy bomber-type aircraft. This weapon was to be used primarily against flights of bomber-type aircraft.

2. To effectively combat mass targets, it was necessary to have a mass weapon which could be produced cheaply and in great quantities. As a consequence, certain basic requirements had to be kept in mind in designing such a weapon. A remote control rocket with either radio, ultraviolet, or similar control from its launching site,

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as well as a self-controlled rocket, was never taken into consideration for the purpose of fighting bomber formations. Considering the fact that a remote or nearby effect of the highly powerful [redacted] would demand an extremely large charge as compared to a direct hit, the utilization of proximity fuzes could be dispensed with by using this type rocket. The effect at the target is caused exclusively by a charge of the above-mentioned explosives, consisting of about 500 grams each, where the detonation occurs by means of a highly sensitive [redacted] delay moment involved. Ballistic calculation proved to the Germans that the required flying [redacted] and its specific impulse ispec is equal to [redacted] Subsequent ballistic experiments, furthermore, proved that especially favorable conditions for the two-stage rocket were found when the initial stage, as well as the [redacted]

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Launching Platform

3. Multiple instruments were provided for launching with a rate of fire of five rounds per minute for the individual rockets. However, there was an arrangement whereby four rounds of six rockets each, and two rounds of eight each within a common steel frame were constructively investigated. These were mounted on a launching platform which was adjustable by gun-laying radar in the usual manner for elevation and traverse. As a variation, the utilization of the main stage with payload but without the first stage, for use against low-flying aircraft, was also tested. Ground control with respect to fire control was to have corresponded unchanged to the usual higher performance of AAA, yet naturally omitting the flight time calculations for the timing detonator.

PROJECT "FALKE"

Summary of Characteristics

4. The remote-controlled rocket Falke (air-to-air) with a long-burning powder propelling charge for combatting of flying targets was supposed to have had, generally speaking, the following tactical characteristics:

   a. To be used at altitudes of from zero to twelve kilometers.

   b. Transverse acceleration in flying altitudes of from six to eight kilometers about ten g, equal to about 100m/second^2.

   c. Maximum velocity of rocket at altitudes of from six to eight kilometers approximately 500m/second.

   d. Combustion period of rocket at least ten seconds.

   e. Velocity advantage of the carrier aircraft as opposed to the target - about 50m/second.

   f. Velocity of flying target up to 1250 kilometers/hour.

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g. Manner of utilization of rocket: pursuit flight.

h. Effect on target: incendiary splinters and blast shockwave of warhead.

i. Detonation: electrical or accoustical (proximity fuze) minimum detonator.

j. Control: UHF radio installation with pulse-command transmission.

Design Construction

5. [redacted] attempted to reconstruct the overall data of the rocket in dimensions which are only approximate to those used at that time. /See page 6. / By means of prolonged calculations, the Germans arrived at the design values for the individual components. Here it must be mentioned that the wind tunnel results of profile and fuselage models, as requested [redacted] were not placed at the disposal of the German work group, so that the necessary dimensions had to be calculated on a theoretical basis through analysis of the Rheintochter wind tunnel measurements and development processes. 25X1

DESIGN DATA FOR THE ZENITH MISSILE

6. The design data for the Zenith missile are as follows:

1. Initial Stage:	Caliber	approx 12 cm
	Charge Load	approx 11.3 kg
	Dimensions:	
	External Diameter	approx 107mm
	Chamber	approx 15mm
	Length	approx 840mm
	Combustion Time	approx 3.8sec
	Thrust	approx 2200kg
	Weight of Empty Rocket Chamber including supporting areas	approx 14.5kg
	Thickness of Rocket Chamber (internal surfaces are protected against glowing through by means of thermo-insulating lacquer)	approx 2.7mm
	Length of Rocket Chamber:	approx 1020mm
2. Main (Second) Stage:	Caliber	approx 68mm
	Weight of Propelling Charge (Ngl.RP)	approx 2.1kg
	Dimensions:	
	External Diameter	approx 61mm
	Chamber	approx 8.5mm
	Length	approx 475mm
	Combustion Time	approx 2.2 sec
	Weight of empty rocket chamber	approx 2.35kg
	(internal surface is insulated against glowing through by means of thermo-insulating lacquer)	approx 1.5mm
	Length of rocket chamber	approx 575mm

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[redacted]

3. Payload: Weight of explosive charge approx 500 gr

[redacted]

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3. Payload:	Weight of hull inclusive detonator & stabilizer (on rocket chamber)	approx 700 gr
4. Total Weapon:	Total (over-all) weight	approx 32 kg
	Over-all length	approx 1750mm
	Nominal velocity increase through rocket-base (initial stage)	approx 840m/s
	Main (second) stage	approx 820m/s
	Total velocity increase	approx 1660m/s

7. The most favorable moment for the separation of the initial rocket (by means of the powder gases of the initial stage) was variable under various conditions, but in all instances it had to occur shortly after completion of initial-stage propellant combustion. This result stands in opposition to the utilization conditions of a multi-stage rocket for which the achievement of maximum distance is desired. The main stage and payload in this case were not to be separated during continued flight.

AERODYNAMICS

8. The canard-type of construction, that is, with rudders arranged at the bow of the missiles, was chosen:

   a. To guarantee the effectiveness of the rudder in all flight positions.

   b. To make available at altitude the lift forces acting on the rudder surfaces towards the total lift available.

9. The pronounced sweepback of the wings was chosen, aside from the supersonic principles, in order to obtain a sufficient dc_m/α. As lift-coefficient, based upon a Mach number of v/a about 1.5, a value of 0.05 for each degree of angle of incidence was accepted for incidence of up to seven degrees, whereas, the resistance coefficient of the wings, within the regions of from zero to seven degrees, was assumed to be within an increase of from 0.12 to 0.17. The fuselage was, in assuming a nominal diameter of bulkhead with 300 millimeters, considered to have a resistance coefficient of c_w of about 0.4 at zero degrees incidence, a value which might rise to about 0.6 at an angle of seven degrees. The calculation of flight characteristics, during the passing-through all Mach numbers, was achieved according to a process of resistance, as ascertained within the USSR according to SCHAPIRO, whereby a similar rule was laid out for the progress of lift. The calculations proved that the demands made for the proposed design would be met with a wide margin of success (so far as the assumed aerodynamic prerequisites were attainable). During the fighting against aircraft at the upper speed range, especially during low flight altitudes, the fighting range fell naturally to a marginal value of 1200 meters and below, whereas, during the fighting-off of aircraft with inherent velocities of about 900 kilometers/hour, the maximum fighting separation of 1800 meters could, especially at altitudes of

considerable value, be exceeded considerably. The lower fighting separation was determined in this case by a minimum target pick-up time of five seconds limitation.

CONTROL

10. The control of the flying missile was scheduled to be affected solely by means of the rudders attached to its head in dispensation of the usual traverse rudder. For this reason, it was imperative to design the rudder installation as a special vertical and horizontal combination, that is, each rudder vane had to be adjustable individually. The steering knob built into the pilot's compartment of the aircraft then interpolated the stick movements into polar coordinates. Then, by means of a special potentiometer circuit, these values were transmitted to the missile by decimeter carrier wave common for both, the right as well as the left vanes, through variations in the pulsing correlation of each individual control channel. Within the missile, after filtering of the low frequencies of the left-hand and right-hand channel, under admixture of the indicated values of the directional gyro of the switching box, a change to electro-mechanical commands for the Servo-unit [see page 7]. Steering was accomplished after a line of sight trajectory.

VARIATIONS

11. Taking into consideration dimensions, instruments of lesser acceleration were likewise investigated, whereby the smaller wings led to smaller overall dimensions. Also, variations for payloads were considered. Furthermore, the utilization of a hinged wing unit was supposed to be investigated constructively, but was never done due to centralization of remote-controlled rockets within another Ministry in Putilovo (USSR). A predecessor of the project development was represented by the Project Moeve as elaborated on and worked on in the Technical Design Office of Oberschoeneweide, Berlin. However, this instrument was designed for the current aircraft speeds and altitudes of up to eight kilometers. Consequently, the total weight amounted to merely 140 kilograms.

PAGE 6 : Falke Rocket for Fighting Bombers with Legend.

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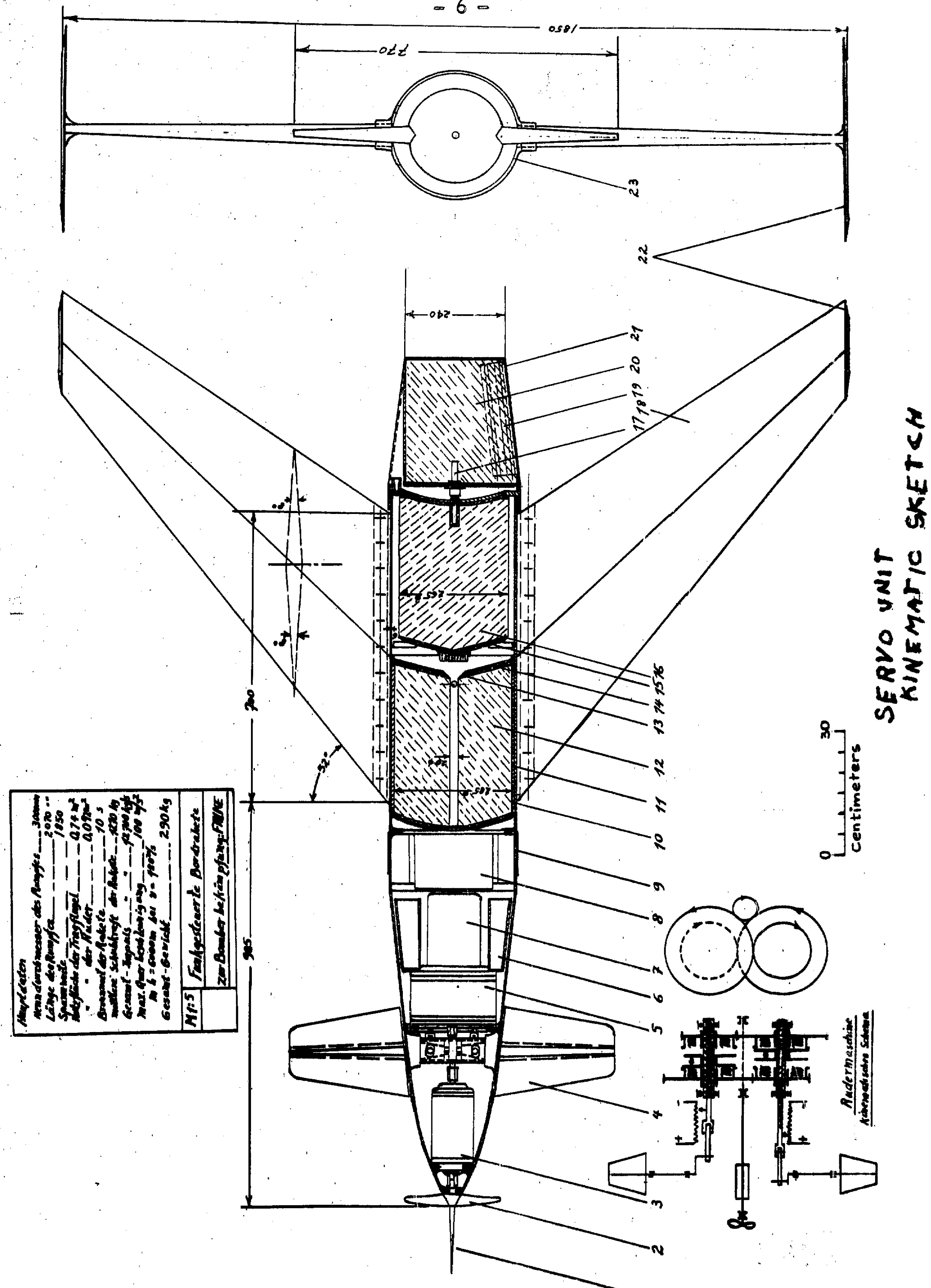

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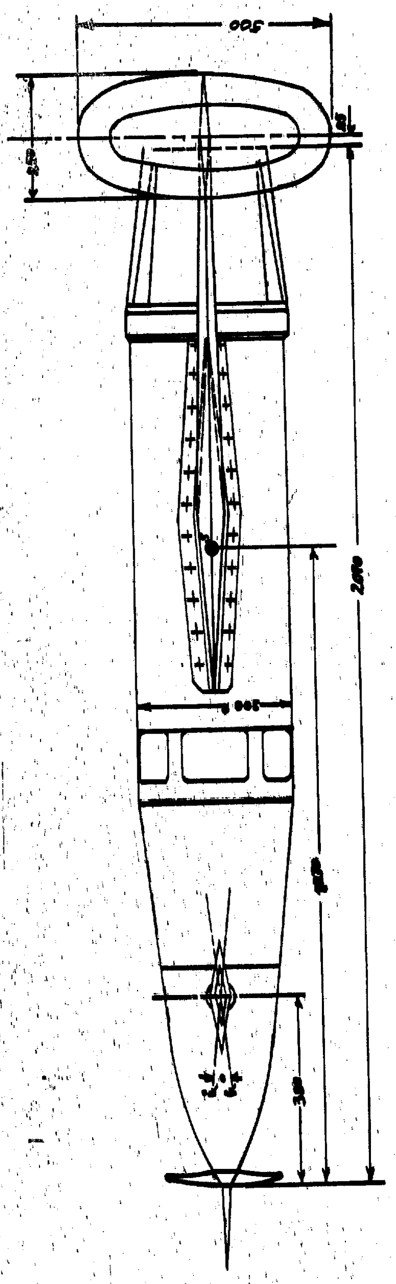

SERVO UNIT
KINEMATIC SKETCH

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LEGEND

The positions marked are described as follows: [see drawing]

1. Dipole antenna as a combined receiving-transmitting antenna for the electrical proximity detonator.

2. Supersonic propeller drive for the electronic installations in No. 3 and No. 5 position. The hollow propeller shaft has insulator bushings under the above-mentioned dipole antenna (see 1.). Here it might be mentioned that a variant was tested, using instead of the supersonic propeller a ramjet turbine, but the installation did not work well due to icing conditions which were not corrected.

3. DC-AC generator inverter for the generation of plate voltages for Position No. 8 (250V DC) and the 24V DC for the magnetic coupling of Position 5 as well as the three-phase AC inverter for the damped-position-gyro of Position 7 at 500 cps.

4. Control rudder with plus or minus 7° variability. For a profile, an acute symmetric rhombus was selected. The left and the right rudders are independent of each other and controlled by the Servo-unit. Each rudder has one needle and one ball-bearing support. The rudders are sheet steel (approx. 4mm) and welded onto the rudder shaft which is shaped like a conical thorn.

5. Electro-mechanical servo-unit, whose kinetic system may be seen from the sketch at the lower left [see drawing]. The control adjustment is produced by the supersonic propeller, and is fed to the electro-generator and then the central driving-gear wheel. This wheel is geared to the left front and right rear drive wheels. Each of the rudders meshes with a slightly smaller counter-wheel so that either left-hand or right-hand turning is possible. The coupling shafts, with trapezoidal internal threads, are led out of the Servo-unit housing through the hollow shafts of the front wheels. They have the trapezoidal thread spindles whose yokes are coupled with a joint lash to the adjusting lever of the rudder axle. Each of the cogwheels is built as a pot magnet, and carries an excitation winding that is fed by means of feed rings. The coupling shaft has an axially-arranged displaceable friction disc, constructed as an armature. Through excitation of the forward or rear pot magnet, the clutch coupling disc is pressed into the corresponding cog-wheel so that the coupling shaft may be switched from right to left for rotation as desired. The frequency of shifting of this arrangement is given at fifty per cent of the self-induction of the exciter winding and of the mass inertia of the coupling disc. It amounts to about four seconds. Rigidly combined with the outer rim is the Servo-unit.

6. The housing for the electrical control instruments, capacitor, resistance, amplifier tubes, and relay. The feed-back potentiometers (for reporting back of incidental rudder position) are built in solidly within the Servo-unit. They are coupled together with the threaded shafts.

7. Centrally-flanged onto the Servo-unit is the damped-directional-gyro whose interlock is released automatically at the moment of launching.

8. UHF radio receiver, whose construction was copied from the Rheintochter instrument. By means of an antenna tuning device, it is connected to the two wings, which have metal sprayed on them in the shape of antenna-strips. It was intended to use amplifier tubes with negative temperature coefficient cathodes (German patent - myself) in order to save on the generator output. The activation of the complete installation occurred through freeing, electrically, of the supersonic propeller from the observing site. In view of the low dynamic pressure during initial acceleration for the actuation of the installation, the electric generator was connected to the mother aircraft's supply, thus, functioning as a would-be rotary converter, generating the necessary power. Simultaneously with this, the heating of the negative temperature coefficient cathodes had to occur through the aircraft's supply. After launching, the inertia of the generator's stored energy was great enough to operate the installation until sufficient ram pressure of the rocket was attained to satisfy necessary power requirements. The slow cathodes had a sufficient heat-holding capacity for a period of fifteen seconds operation.

9. The front part of the fuselage was constructed of about four milimeters thick aluminum sheet metal, which also served as housing for all control components. It was connected to the long-burning powder-propulsion unit, which was arranged within the region of the center of gravity by means of flanges.

10. Rocket chamber for the powder-propulsions plant. The rear half of the chamber had a coating of silicate thermo-insulation which was sprayed on.

11. Gelatinous-like thermo-insulating mass.

12. Frontal powder block (about 35 kilograms), overall thermally-insulated, except for a 20 milimeter center hole.

13. Bakelite-like thermal insulating mass on rear traverse of plane.

14. Steel protective cover, to avoid mechanical damage to the rear thermal insulation by hot powder gases.

15. As in 14, but for the protection of front traverse of the rear powder body.

16. Rear powder body (approx 30 kilograms). Front and rear traverse planes thermally-insulated. Whereas, the combustion process of the front powder charge proceeds from the center outward, the combustion front of the rear body progresses accordingly from the outside centrally towards the central axis so that, during the period of combustion, a uniform surface ratio is maintained. Since the front powder body experiences a continuously increasing loss of weight, and the rear powder body shows a continuous voluminous decrease, the center of gravity moves

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during combustion first forward and then, after combustion, returns to the approximate point of origin. The coverlid of the rocket chamber arranged in the rear, has six equi-distantly spaced jets on its circumference. It was impossible to orientate the directivity of the jets to that of the center of gravity, in this design, since that would have meant too great a loss of propulsive thrust. Nevertheless, an orientation of direction up to about ten degrees would still be acceptable.

17. Electrical firing installation for the explosive charge.

18. Wing (pair) with supersonic profile. Acute rhombus with d/t about 1/14 or eventually narrower yet.

19. Incendiary fragments, according to dimensions as with R100BS, about three hundred pieces, that is, 18 kilograms over-all.

20. Blasting charge: about 30 kilograms of trinitrotoluene.

21. Aluminum container, of three milimeters heavy sheet metal, for blasting charge. On its circumference, six pocket-like bays for jet stream.

22. Final discs, 250 X 500 milimeters as damping fins for vibration about Y-axis.

23. Mounting angle brackets of wings welded to chamber cover.